

ENERGY EFFICIENCY IN CALIFORNIA AND THE UNITED STATES

Reducing Energy Costs and Greenhouse Gas Emissions

Audrey B. Chang, Natural Resources Defense Council, Corresponding Author,
ACHang@NRDC.org

Arthur H. Rosenfeld, and Patrick K. McAuliffe, California Energy Commission
ARosenfe@ or PMcAulif@Energy.State.CA.US

Introduction

The production of energy is among the largest sources of greenhouse gas (GHG) emissions that contribute to global climate change. Fortunately, several strategies can reduce GHG emissions associated with energy use: the use of less energy to provide the same or better service; increased use of alternative energy technologies such as renewable resources that have zero emissions; improved technology for burning the fossil fuels (such as coal, natural gas and petroleum) that are conventionally used to produce electricity and run our cars; and permanent and safe disposal of the emissions we are not able to reduce. The first of these – a concept commonly known as end-use energy efficiency – is the primary focus of this chapter. Making more efficient use of energy in order to provide the services we need and desire – like lighting, hot showers or cold drinks – is the fastest, cleanest, and cheapest energy resource currently available and thus represents the most effective near-term technological option to reduce GHG emissions across the world. It should be highlighted, however, that energy efficiency alone will not be sufficient to achieve the GHG emission reductions necessary to avoid catastrophic,

irreversible consequences of climate change; an integrated approach to reduce emissions throughout the energy sector is essential.

In this chapter, we examine the United States (U.S.) and California in particular as case studies of energy efficiency. We first discuss efficiency gains in the U.S. and then turn to a more detailed discussion of California's experience with energy efficiency, primarily in the electricity sector.

Surprising Energy Efficiency Gains in the United States

The U.S. has made energy efficiency improvements that have benefited its economy and reduced its GHG emissions. A common measure of energy efficiency is energy intensity, defined as the quantity of primary energy, not just electricity, consumed per unit of gross domestic product (E/GDP). Energy intensity in the U.S. has declined at five times the historical rate since the 1973-74 oil crisis raised the price of energy, awareness of energy consumption, and also the profile of energy efficiency. If, instead of the actual 2.1 percent decline per year experienced since 1973, the U.S.'s energy intensity had decreased by only the business-as-usual pre-1973 rate of 0.4 percent per year, energy use in the country would have risen by approximately an additional 70 quadrillion Btus (quads) in 2005 (see **Figure 1**). Even with this improvement, primary energy use still climbed by 25 quads during these three decades.

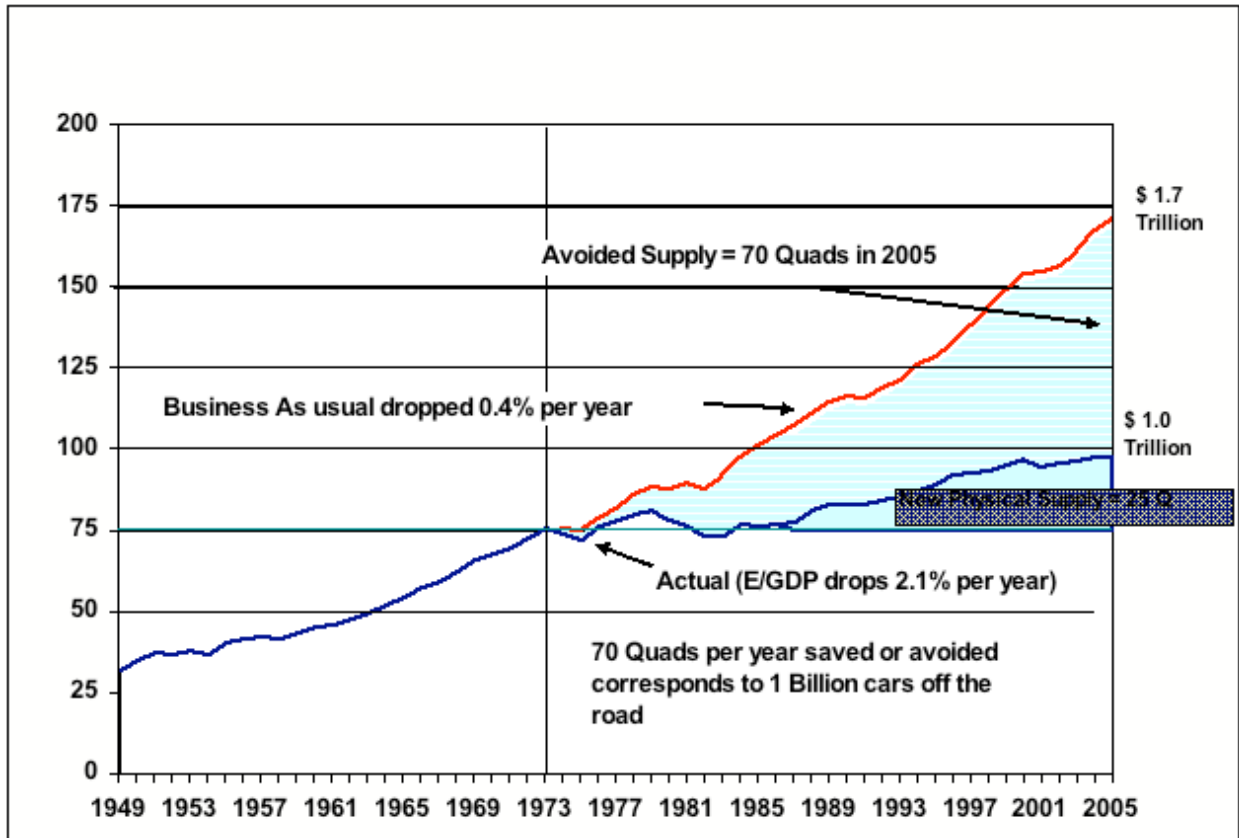


Figure 1: Energy Consumption in the U.S. at Actual and Business As Usual Rates of Declining Energy Intensity.¹ The vertical line marks the 1973 oil embargo.

The U.S. government's own energy policy reports from 2001 have confirmed that the decreasing energy intensity of the country's economy is due to gains in energy efficiency:

Had energy use kept pace with economic growth, the nation would have consumed 171 quadrillion British thermal units (Btus) last year instead of 99 quadrillion Btus. About a third to a half of these savings resulted from shifts in the economy. The other half to two-thirds resulted from greater energy efficiency.²

This avoided supply of energy, the majority of which was displaced by improved energy efficiency, corresponds to approximately \$700 billion of annual savings (avoided expenditures that are available to be invested in growing other parts of the economy). We estimate that the 70 quads per year of avoided energy supply in 2005 is equivalent to avoided emissions of 4.2 billion

metric tons of carbon dioxide (CO₂), the primary GHG, or the GHG reductions equivalent to taking 800 million cars off the road (consider that there are currently only 600 million cars in the world). The actual U.S. emissions in that year were nearly 6 billion tons.³ In addition, the 70 quads per year avoided is equivalent to an oil flow of approximately 33 million barrels a day, two-fifths of the world's current oil production of 84 million barrels a day.⁴

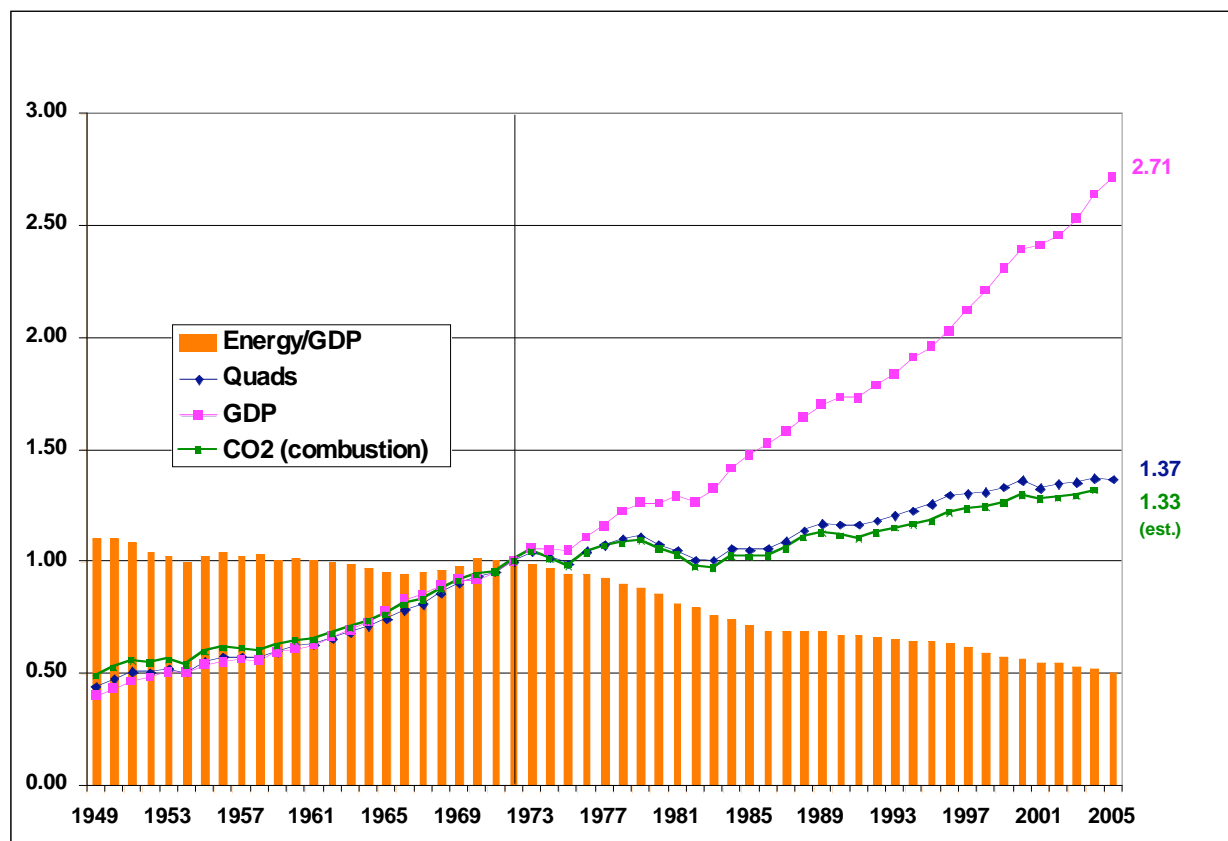


Figure 2: U.S. Primary Energy Use, Energy Intensity, GDP, and CO₂ emissions⁵, all indexed to 1972⁶

Such gains are laudable and important from both an economic and an environmental perspective. **Figure 2** plots the same U.S. energy consumption data as Figure 1, indexed to a 1972 baseline, along with CO₂ emissions during the same timeframe. Prior to 1973, primary energy use, gross domestic product (GDP), and CO₂ emissions from combustion increased nearly in lockstep – energy intensity changed little. After 1973, these relationships dramatically changed: GDP and energy use were uncoupled and energy intensity improved rapidly. Interestingly, from

1979 to 1983 CO₂ emissions actually declined, caused by individual state adoption of energy efficiency standards for buildings and appliances, increased fuel prices, and federal corporate average fuel economy (CAFE) standards in the transportation sector. However, CAFE standards have remained virtually unchanged since 1985, and many other energy-saving policies also lapsed or failed to become more aggressive with time. As a result, CO₂ emissions in the U.S. since 1984 have continued to increase, at a rate of 1.3 percent per year.

California: The Role of Energy Efficiency Policy in Reducing GHG Emissions

California, the most populous state in the U.S., is the sixth largest economy but only eleventh largest emitter of GHGs in the world.^{7,8} We use the experience of California as a case study of the potential to reduce GHG emissions through end-use energy efficiency. Since the mid-1970s, California has established itself as a leader in promoting energy efficiency. Recently, the state has also identified energy efficiency as its top priority energy resource and a primary tool for reaching its GHG emission reduction goals.

We focus primarily on electric and natural gas end-use efficiency in our examination of California, because states control regulation of utilities in these sectors.ⁱ In the transportation sector, weak federal efficiency standards, substantially unchanged since 1985, are an obstacle to state-level progress. Key characteristics of California's electricity and end-use natural gas utility sectors are summarized in **Table 1**.

Electricity	End-Use Natural Gas
272 TWh per year	1.3 quadrillion British thermal units (Btus) per year
60 GW summer peak load	58% of total natural gas consumption ⁱⁱ

ⁱ For the remainder of this chapter, we use “energy efficiency” to refer to electric and natural gas end-use efficiency, unless otherwise stated.

ⁱⁱ The remainder of California's natural gas consumption is used for electricity generation.

\$35 billion per year industry revenues	\$12 billion per year industry revenues
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Table 1: California Electricity and Natural Gas Utility System Overview (2005)⁹

An Overview of California's Greenhouse Gas Emissions

Overall, California's total GHG emissions have grown over time and are projected to continue to do so under business-as-usual (BAU) trends. Since 1990, California's GHG emissions have increased at a rate of 1.0 percent per year and are projected to grow at 1.2 percent per year if existing patterns of energy use continue. **Figure 3** illustrates California's total historical and projected BAU CO₂-equivalent emissions, including combustion emissions associated with imported electricity as well as emissions from non-combustion sources.ⁱⁱⁱ Also included in Figure 3 is the straight-line trajectory to meet the 2020 statewide limit on GHG emissions, which represents a return to the state's 1990 emissions levels that is mandated by Assembly Bill (AB) 32, the state's Global Warming Solutions Act of 2006.^{iv}

ⁱⁱⁱ Emissions associated with international bunker fuels are not included.

^{iv} Assembly Bill (AB) 32 (Núñez /Pavley) was signed by Governor Arnold Schwarzenegger in September 2006.

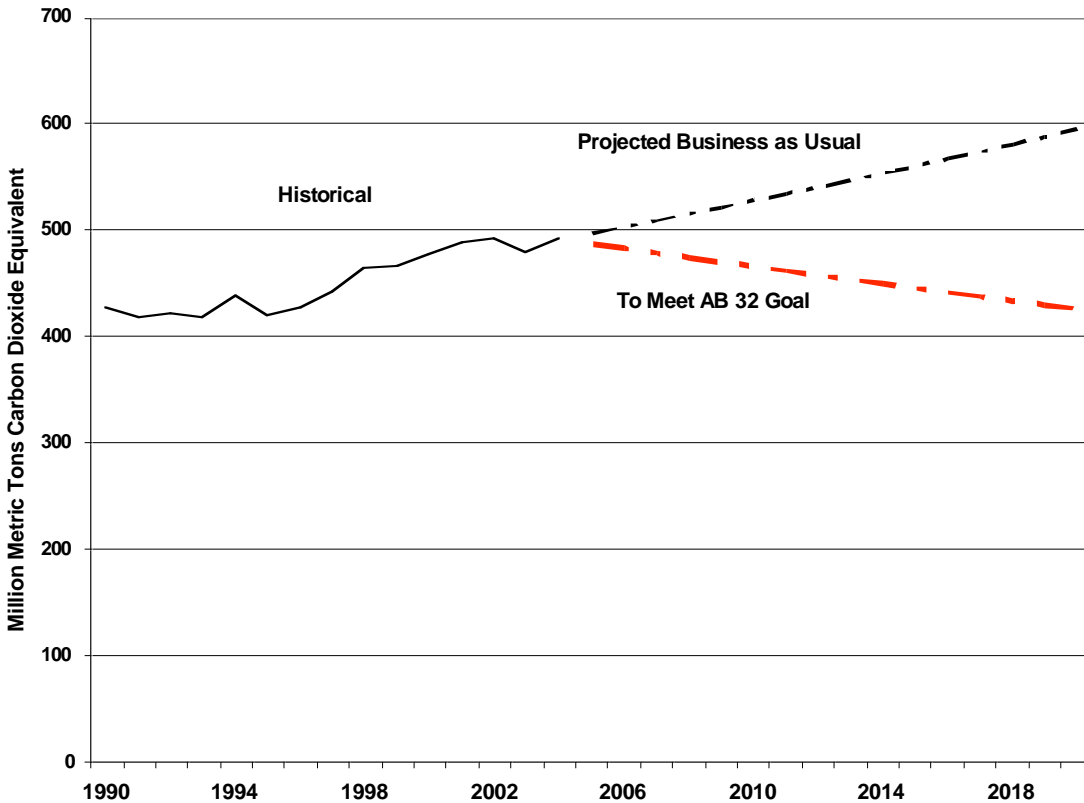


Figure 3: Historical and Projected California GHG Emissions.¹⁰ Also see Figure 6 regarding the mix of strategies expected to meet the AB 32 2020 GHG emissions limit.

Although absolute GHG emissions have risen over the past few decades, per capita CO₂ emissions in California have declined. **Figure 4** shows that CO₂ emissions per capita in California, even including the generally increasing contributions from imported power, are still considerably below the U.S. average. Whereas per capita CO₂ emissions in the rest of the U.S. have remained essentially level since 1990, per capita CO₂ emissions have decreased by 0.3 percent per year and are now 40 percent below the rest of the U.S. Although the lowering of per capita emissions is laudable, it is also important to note that in absolute terms (as opposed to per capita) from 1990 to 2003, California's total GHG emissions increased by 12 percent, but gross state product grew by 83 percent over the same period.¹¹

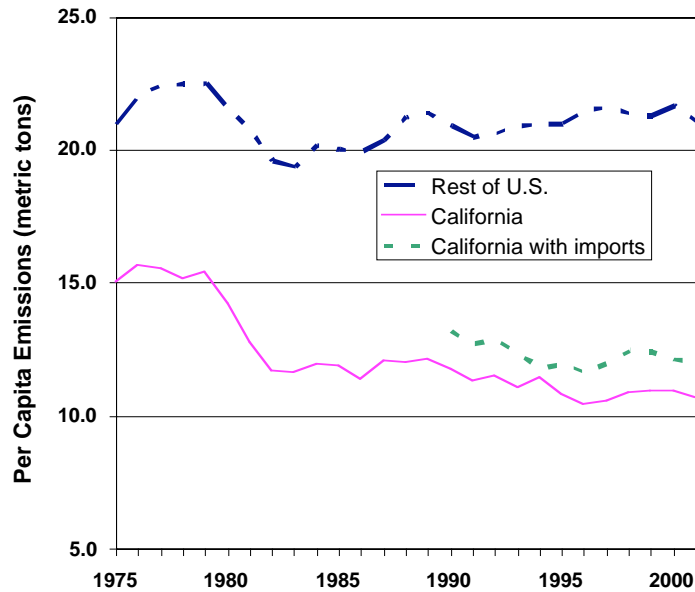


Figure 4: Per Capita CO₂ Emissions in California and Rest of U.S.¹²

Figure 5 shows the relative contribution to GHG emissions by end-use consumption as well as non-combustion sources in California in 2004. Significant opportunities exist to improve the energy efficiency of any of these end-uses and thus reduce GHG emissions. Transportation is the largest source of GHG emissions (41 percent). As mentioned previously, the state has been preempted by U.S. federal laws from mandating efficiency improvements in this sector. However, Massachusetts and several other states sued the U.S. Environmental Protection Agency (EPA) to require the EPA to regulate CO₂ and other GHGs under the Clean Air Act; in April 2007, the U.S. Supreme Court found that the Clean Air Act does give the EPA the authority to regulate GHGs and required the EPA to consider how it will or will not regulate GHG emissions.¹³ In a related case, automobile manufacturers and dealers are in the midst of a lawsuit against the state of California in federal court contesting a 2002 California law to reduce CO₂ tailpipe emissions from automobiles (AB 1493, Pavley).¹⁴ After transportation, electricity consumed by buildings and industry (including electricity imported from out-of-state) is the

second largest source of California's GHG emissions, totaling 108 million metric tons of CO₂-equivalent (MmtCO₂eq)^v and accounting for 22 percent (of the state's total GHG emissions). Natural gas use in buildings and industry contribute another 14 percent of California's GHG emissions.

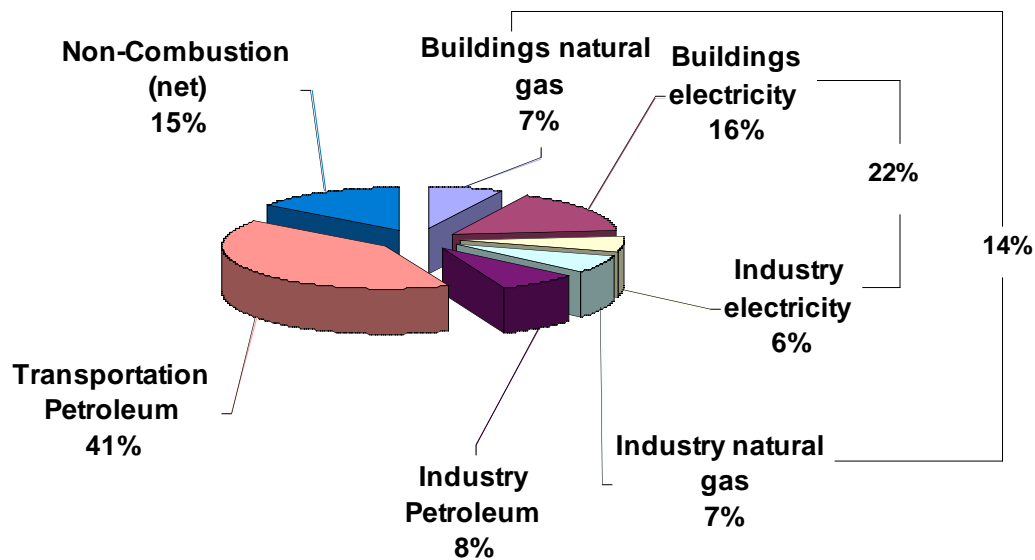


Figure 5: California GHG Emissions by End-Use, including electricity imports (total emissions in 2004 = 490 MmtCO₂eq).¹⁵

In considering the GHG emissions of California's electricity sector, we count the emissions associated with *all* of the electricity the state consumes, rather than just emissions from electricity generated within the state's boundaries. In a typical year, 22 to 32 percent of California's electricity is imported from out-of-state generating units, many of which are coal-fired facilities that emit large amounts of GHGs.¹⁶ On the whole, out-of-state electricity generation that is consumed in California has more than double the carbon intensity of in-state

^v Million metric tons of CO₂ equivalent will be abbreviated as MmtCO₂eq in this chapter.

generation.¹⁷ Although imported power represents less than one-third of the total electricity consumed in the state, it is responsible for roughly *half* of the GHG emissions associated with electricity use in California.¹⁸ This difference underscores the importance of accounting for the emissions associated with electricity imports to capture the emissions impact of the state's electricity consumption.

Energy Efficiency: California's Foundation for Reducing its GHG Emissions

In June 2005, Governor Schwarzenegger signed Executive Order S-3-04, which established aggressive GHG reduction targets for California: reduce GHG emissions to 2000 levels by 2010; to 1990 levels by 2020; and to 80 percent below 1990 levels by 2050.¹⁹ The 2020 emissions reduction goal was subsequently codified by Assembly Bill (AB) 32, California's Global Warming Solutions Act of 2006, which was signed into law by the governor in September 2006.

Figure 6 illustrates that strategies to meet the 2020 GHG reduction goal will span many sectors. Energy efficiency strategies figure prominently in the state's plan for meeting the 2010 and 2020 GHG reduction goals. Some of these strategies involve efficiency efforts already underway. For example, currently-funded programs and existing efficiency standards in the electricity and natural gas sectors are expected to save 15.8 MmtCO₂eq in 2020 (about nine percent of what will be needed to meet the state's goal).²⁰ In all, existing and expanded efficiency improvements in the buildings and industry sectors are expected to contribute at least 17 percent of the total GHG reductions needed to meet the state's 2020 goal. These contributions to California's emissions reduction goals should be even greater than Figure 6 indicates, as the

GHG reductions resulting from future improvements to the state’s building and appliance energy efficiency codes and standards have yet to be determined.

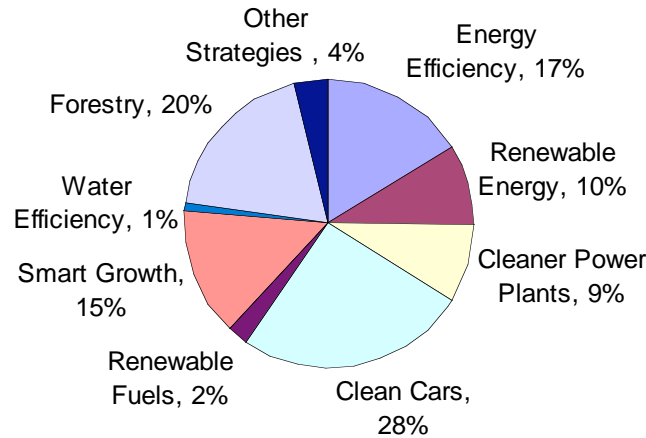


Figure 6: Strategies for Meeting California’s 2020 GHG Reduction Goals
(Expected total reductions of 174 MmtCO₂eq from business-as-usual projected emissions of 600 MmtCO₂eq in 2020).²¹ See Figure 3 for data time perspective of these reductions.

We also note that outside of the electricity and natural gas sectors, a large portion of the estimated reductions from the transportation sector (i.e., “clean cars” in Figure 6) are expected to come from technological improvements to enhance that sector’s end-use energy efficiency. Specifically, AB 1493 (Pavley, 2002), which aims to decrease the tailpipe GHG emissions from vehicles, will also result in improved efficiency. Reducing emissions from power plants (“cleaner power plants”) will likewise involve deploying more efficient technologies. In total, energy efficiency strategies of all types and from all sectors will likely contribute nearly *half* of California’s total targeted GHG emission reduction by 2020.

It is clear that cost-effective electric and natural gas end-use efficiency has a critical role in combating climate change while providing for the energy needs of the state. California has had a successful history of integrating energy efficiency programs and standards, but more energy saving potential remains. Future improvements to the California building and appliance

standards, extending the investor-owned utility energy savings goals beyond their current 2013 timeframe, and efficiency contributions from the state's publicly-owned utilities are all necessary components of California's ambitious plans to reduce its GHG emissions.²² In total, these electric and natural gas energy efficiency strategies will reduce the state's emissions by at least 30 MmtCO₂eq.²³

Energy efficiency is the important foundation to help California meet its GHG reduction goal, but to fulfill it, California will need to develop and implement aggressive GHG reduction strategies in all sectors of its economy. If the state is to achieve its goal of reducing GHG emissions in 2020 to 1990 levels, considerable additional effort will be needed. Energy efficiency policies and programs in the electricity sector provide clear and convincing evidence that such efforts can be cost-effective and environmentally sound.

Historical Energy Efficiency Accomplishments in California

California has pursued strong energy efficiency programs and policies, starting with the establishment of the state's appliance (Title 20) and new-building (Title 24) standards in 1976 and 1978, respectively, and concurrent investments in energy efficiency programs across the state. **Figure 7** shows that California's historical energy efficiency policies have enabled the state to hold per capita electricity use essentially constant, while in the U.S. as a whole, per capita electricity use increased by nearly 50 percent since the mid-1970s.²⁴

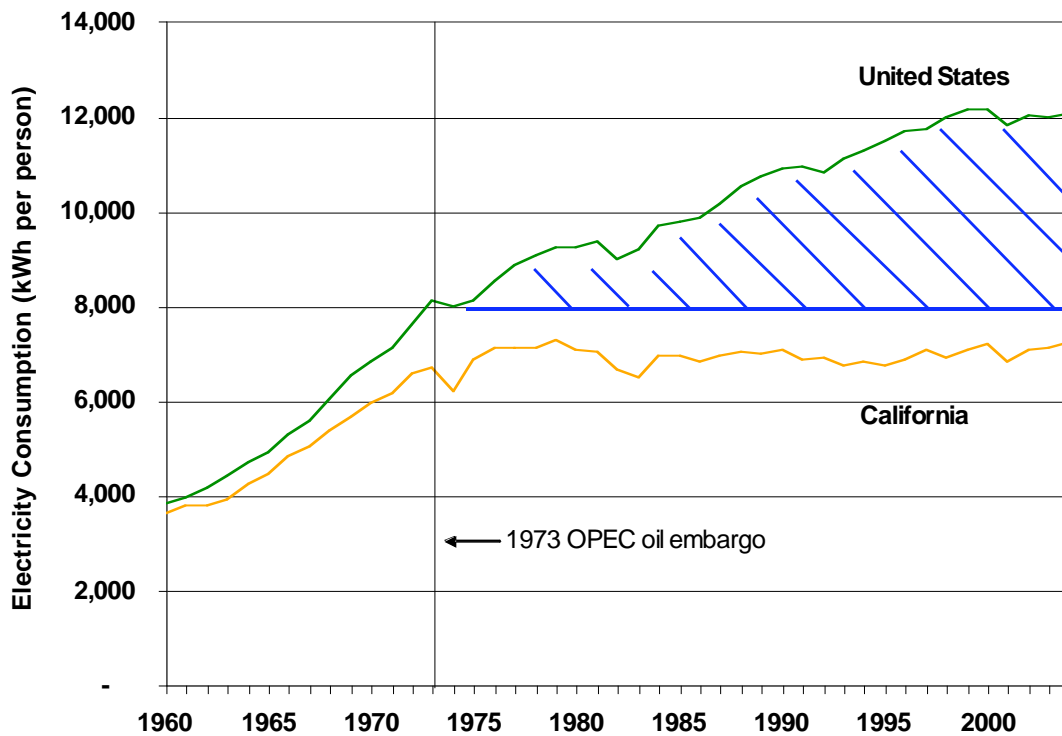


Figure 7: Per Capita Electricity Consumption in California and the U.S.²⁵

Differences in energy policy between California and the rest of the U.S. partially explain these divergent paths in per-capita electricity consumption. Although California's relatively low per-capita consumption is partly due to a milder climate, the state's gradual transition over time from a manufacturing-based economy to a service-based economy, and the demand-dampening effect of higher electricity prices, a significant portion of the difference in per-capita electricity use, as compared to the rest of the U.S., is due to policies and programs aimed at more efficient use of electricity. If California's per capita emissions had grown at the same rate as the rest of the country since 1975, the state would have needed approximately 50 additional medium-sized (500 MW) power plants.

California's success in energy efficiency policy rests on an integrated three-pronged approach:

1. Research and development activities generate new energy efficiency technologies and strategies. California's Public Interest Energy Research budget is about \$80 million per year.²⁶
2. As these new technologies are introduced commercially, the state's utilities administer rebate and education programs to accelerate their penetration into the marketplace. The state's investor-owned utilities' energy efficiency budget in 2006 was almost \$700 million.²⁷
3. Finally, as these energy efficient technologies become more commonplace, their higher level of performance is incorporated into building and appliance standards. The total cost of developing these standards is in the range of \$10-\$20 million per year.²⁸

Roughly half of California's policy-driven energy savings have come from building and appliance standards that have been progressively strengthened every few years. The other half of these savings has resulted from utility programs that promote deployment of energy efficient technologies. **Figure 8** shows the annual energy savings from California's energy efficiency programs and standards since 1975. Through 2003, these policies have cumulated in about 40,000 GWh of annual energy savings and have avoided 12,000 megawatts (MW) of demand (MW data not shown in graph) – the same as twenty-four 500-MW power plants.²⁹ These savings will only continue to grow.

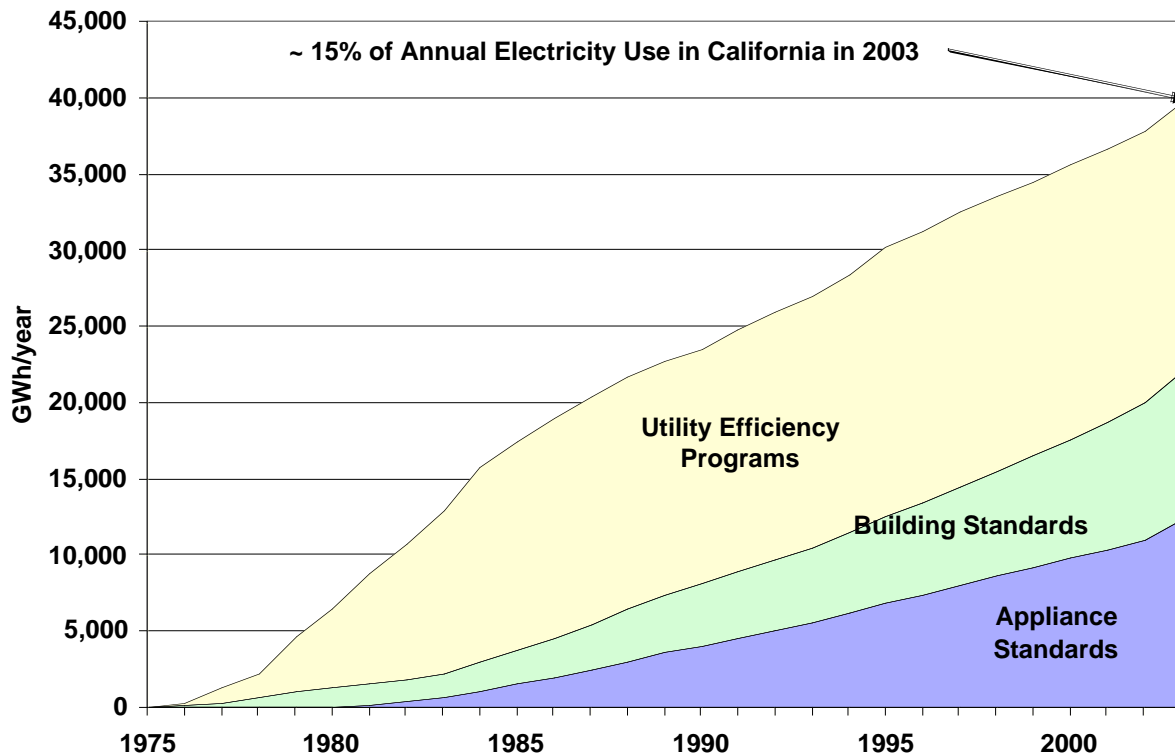


Figure 8: California's Annual Energy Savings from Efficiency Programs and Standards³⁰

When summed together, the three decades of energy efficiency programs and standards have resulted in annual efficiency savings today equivalent to approximately 15 percent of California's annual electricity consumption, as shown in Figure 8.^{vi} These savings have reduced CO₂ emissions from the electricity generation sector by nearly 20 percent compared to what otherwise might have happened without these programs and standards.^{vii} This equates to an avoidance of CO₂ emissions in the state as a whole of about four percent due to historical energy efficiency programs and standards.^{viii}

^{vi} In reality, the actual statewide savings have likely been even greater, since the utility efficiency programs shown here include only those savings reported by the regulated investor-owned utilities in the state, and do not include efficiency program savings from the municipal utilities, which account for about a quarter of the state's electricity sales.

^{vii} This calculation is based on a marginal CO₂ emissions rate of nearly 0.5 tons per MWh for a natural gas fired powerplant with a marginal heat rate of just over 9,000 btu/kWh.

^{viii} Calculated from the product of 22 percent of the state's CO₂ emissions from electricity consumption (Figure 5) and the reduction of 20 percent in electricity use due to standards and programs (Figure 7).

California's leadership in setting energy efficiency standards began in 1976, when it was the first state in the nation to adopt efficiency standards for appliances. Other states soon followed, eventually leading to federal standards in the National Appliance Energy Conservation Act of 1987. This pattern continues today. Efficiency standards first adopted by California are frequently adopted by other states, the federal government, and even by countries around the world, including Russia and China. These standards are regularly updated and strengthened every few years, ensuring that California's buildings and appliances will remain the most energy efficient in the nation.

The establishment of a policy to remove the disincentive for utility investments in energy efficiency is a key element of California's success in achieving energy savings through utility energy efficiency programs. Under traditional utility regulation, a utility's recovery of its infrastructure investment costs is tied to how much energy it sells. According to this model, energy efficiency results in lower-than-anticipated sales and thus prevents utilities from fully recovering their fixed costs. As a result, traditional regulation deters utilities from investing in energy efficiency and instead encourages them to increase sales to increase revenues. However, since 1982 (with a brief hiatus in the mid-1990s, when market restructuring took resource planning responsibilities away from the utilities), California law has required the state's investor-owned utilities to use modest regular adjustments to electric and gas rates to sever the link between the utilities' financial health and the amount of electricity and natural gas they sell.^{ix} This concept, known as "decoupling," removes significant regulatory and financial barriers to utility investments in cost-effective energy efficiency improvements, and helps align the interests

^{ix} California Public Utilities Code Section 739.10 states: "The commission shall ensure that errors in estimates of demand elasticity or sales do not result in material over or undercollections of the electrical corporations." These rate adjustments typically are made on an annual basis and consist of an adjustment, up or down, of less than two percent of a customer's energy bill.

of utilities and customers. Regulators in several other states in the U.S. have recently followed California's lead by adopting decoupling mechanisms for electric or natural gas utilities (including Idaho, Ohio, Oregon, Maryland, New York, North Carolina, and Utah), and others are considering proposals to do so (including Wisconsin, New Jersey and New Mexico).³¹

While California's energy efficiency standards and programs have helped reduce the state's GHG emissions, they have also delivered substantial net economic benefits to California. The state's efficiency standards, designed to be cost-effective, accelerate energy savings across the state. The cost of efficiency programs from the utility perspective has averaged two to three cents per kWh saved,. This is less than half the cost of the avoided baseload generation – the generation type most often displaced by energy efficiency programs – and is about one-sixth of the cost of peak generation.³² Over the last decade alone, these efficiency programs have provided net benefits of about \$5.3 billion to California's customers from foregone electricity purchases.³³ Though California is often maligned for its high electricity retail *rates* compared to the rest of the U.S., the state's energy efficiency policies have reduced overall energy *bills* for its residents and businesses. Since 1973, on a per capita basis, energy bills in California have averaged \$100 per year less than U.S. bills.^x

Not only is energy efficiency the cheapest and cleanest resource, it also has the shortest lead-time. Whereas a new power plant takes a minimum of several years to plan, permit, and build, energy efficiency measures can be installed in a matter of months or weeks. For example, in a period of 15 months from 2000 to 2001, inefficient incandescent traffic lights with energy-intensive colored lenses were replaced with light-emitting diodes (LEDs) across the state. This relatively simple retrofit saved 186 GWh annually and 29 MW in reduced peak electricity demand.³⁴ Because of its short lead-time and ability to be incrementally deployed, energy

^x see Rosenfeld and McAuliffe, CEC, to be published

efficiency can also be used to more closely follow customer load than the building of power plants, which are typically limited to providing capacity in relatively large portions.^{xi}

California's New Era of Energy Efficiency

Despite California's historical success, significant cost-effective energy efficiency potential still remains. Beginning in 2003, energy efficiency programs in California have been guided by a formal state policy that places cost-effective energy efficiency above all other energy resources. The Energy Action Plan, which was adopted by the state's energy agencies, endorsed by Governor Schwarzenegger, and later updated in 2005, establishes a "loading order" of preferred energy resources. The loading order declares that cost-effective energy efficiency and demand response are the state's top priority procurement resources, followed by renewable energy generation, and finally cleaner and more efficient fossil-fueled generation.³⁵ The loading order now guides all of the state's energy policies and aligns with California's goal of reducing its GHG emissions in the most cost-effective manner.

In 2005, California regulators adopted a new administrative structure for the delivery of energy efficiency programs that charges the state's regulated utilities with fully integrating energy efficiency into their resource procurement process.³⁶ Utilities are now required to invest in energy efficiency whenever it is cheaper than building new power plants, and the savings achieved through these energy efficiency programs will be subject to independent verification. This rigorous evaluation of savings will be essential to ensure that the savings have in fact

^{xi} Although California is now able, due to its sustained energy efficiency efforts over the past 30 years, to quickly deploy energy efficiency programs and implement new standards, we note that this market acceptance of energy efficiency does not necessarily exist outside of California. California's aggressive pursuit of energy efficiency has enabled an infrastructure and market environment that is conducive to these improvements. However, this infrastructure may not exist elsewhere, but other states and countries can look forward to these reduced barriers if they put forward a similar sustained effort and commitment to pursuing energy efficiency.

occurred and can be counted upon for resource planning purposes, as well as for the state's GHG emission reduction goals.^{xii}

After examining the potential for cost-effective achievable energy efficiency improvements in the state, California regulators in 2004 established long-term energy savings goals that are the most aggressive in the nation. Over their ten-year span, these targets will more than double the current level of savings.³⁷ While other states' energy efficiency efforts deliver annual savings ranging from about 0.1 percent to 0.8 percent of their electricity consumption,³⁸ the annual California savings will ramp up to exceed one percent of electricity use. **Figure 9** illustrates the targeted annual savings levels, which significantly surpass historical reductions. In a few years' time, California's per capita electricity consumption, while it has remained steady over the past three decades, should begin to decline. The energy savings goals will avoid nearly 5,000 MW of peak demand over a decade, averting the construction of a new 500-MW power plant every year. Customers will also obtain some relief from rising natural gas bills through the tripling of annual gas savings by the end of the decade.

^{xii} The independent evaluation, measurement, and verification of the energy savings achieved by the utility programs is so important that an average of six percent of the utilities' total 2006-2008 energy efficiency budgets has been set aside for this purpose. (California Public Utilities Commission, Decision 05-11-011, "Interim Opinion: Evaluation, Measurement, and Verification Funding for the 2006-2008 Program Cycle and Related Issues," November 18, 2005; and California Public Utilities Commission, Decision 05-09-043, "Interim Opinion: Energy Efficiency Portfolio Plans and Program Funding Levels for 2006-2008 – Phase 1 Issues," September 22, 2005.)

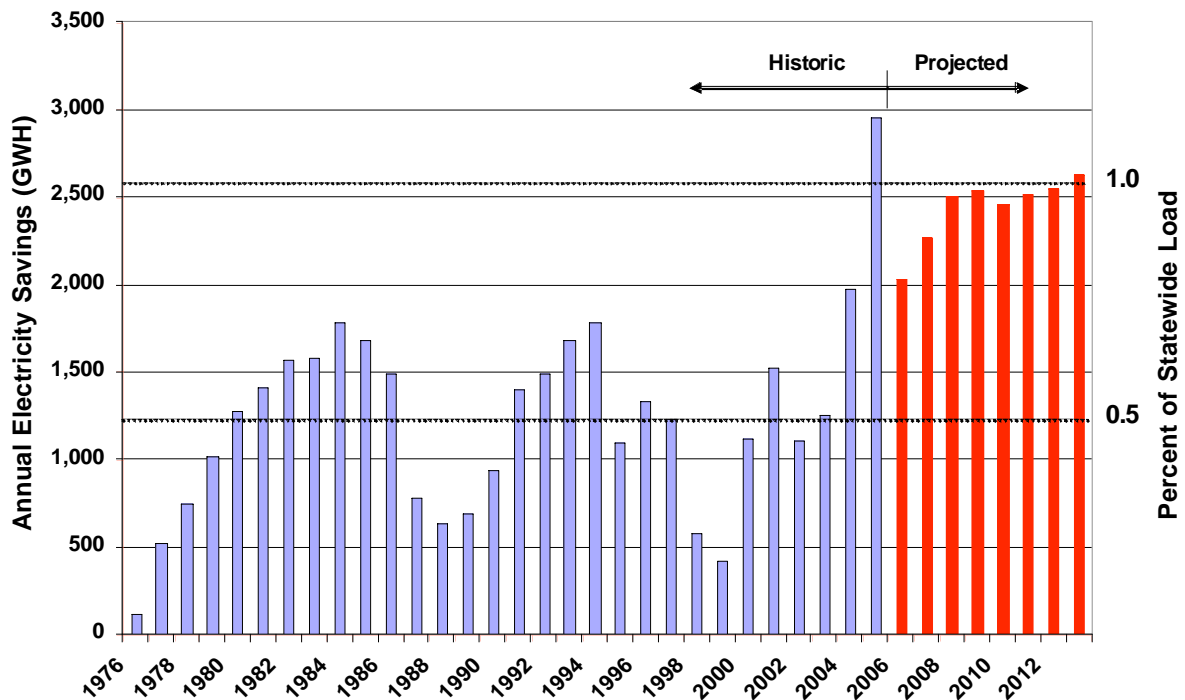


Figure 9: Historical^{xiii} and Projected Electricity Reductions in California³⁹

The historical data in Figure 9 also serve to illustrate the importance of consistent and effective policies to encourage energy efficiency. It is worth noting that energy savings during 1999 and 2000 were the lowest of any year since 1976. This period coincides with the restructuring of California's utility industry and the introduction of retail competition. Voluntary investments by utilities in energy efficiency investments fell by the wayside and were protected only by a mandated system benefits charge (which in California is called the Public Goods Charge). In restructured electricity markets all over the country, the use of systems benefits charges have provided a minimum level of energy efficiency funding in the absence of utility-funded programs. Although energy efficiency programs in California continue to be funded in

^{xiii} Energy savings in 2005 appear to exceed future savings due to a difference in accounting methodology, wherein savings committed to occur in future years (e.g., in new construction projects that were not completed in that year) were included.

part through the systems benefits charge (approximately \$275 million per year for the investor-owned utilities), California's utilities now also use an additional almost \$450 million per year of their supply-side resource procurement budgets to fund nearly two-thirds of their energy efficiency investments.⁴⁰

In 2006, California's utilities began launching aggressive programs to execute their energy savings goals, taking one of the first step toward reaching its GHG reduction goals. The utilities have budgeted \$2 billion to deliver their energy efficiency programs during the three-year cycle from 2006 through 2008.^{xiv} This three-year investment will return nearly \$3 billion in *net* benefits to California's economy through reduced energy bills and the avoided construction of new power plants. Moreover, by 2008, these programs will reduce the state's annual GHG emissions by over three million metric tons of CO₂ (total statewide emissions are currently almost 500 MmtCO₂eq), which is equivalent to removing about 650,000 cars from the roads.⁴¹

Conclusion

Policies to encourage energy efficiency are a realistic and cost-effective strategy to reduce the growth of energy demand, thereby lowering GHG emissions. As the U.S.'s economy and population continue to grow, it is imperative that the rising trend of total GHG emissions in the U.S. be slowed and ultimately reversed. Even in California, where per capita emissions are slowly declining, the state's absolute GHG emissions have risen since the mid-1970s due to continuing population growth of 1.7 percent per year.⁴² By reducing the demand for energy, energy efficiency is inherently the cleanest energy resource, requiring no steel and cement in the ground, no carbon-based fuel supplies, and no new transmission lines.

^{xiv} These programs include rebate programs for energy efficient technologies in buildings and industry, as well as general education about energy efficiency.

The experience of the U.S. and California are examples of how energy efficiency can accelerate the decline of energy intensity. California's sustained electric and natural gas energy efficiency policy efforts, and its success in maintaining lower per capita emissions rates, illustrate the need for continuity of energy efficiency policies to achieve reductions in energy demand growth and GHG emissions. California has far outperformed the U.S. in energy efficiency, but improvements in the U.S. have also yielded decisive economic and environmental benefits.

Looking ahead, California plans to pursue many and varied strategies to achieve its aggressive GHG reduction targets, and energy efficiency will play a key role. Funding and targeted savings levels for end-use energy efficiency in the electricity sector have already increased dramatically in recent years, and the state has recognized that considerable additional efficiency efforts will be needed. Fully fifty percent of the expected reductions in statewide GHG emissions will involve efficiency improvements in various sectors. This chapter demonstrates that energy efficiency should figure prominently in strategies to reduce GHG emissions around the world; in fact, energy efficiency should be the first step.

ENDNOTES

¹ Data source: Energy Information Administration, *Monthly Energy Review (MER)*, available online at: <http://www.eia.doe.gov/emeu/mer/contents.html>, calculations by authors.

² Cheney, Dick, et al. *National Energy Policy: Report of the National Energy Policy Development Group*, May 2001, p. 1-4.

³ To convert the 70 quads/year of fuel avoided to tons of CO₂, we use current CO₂ emission rate of 60 million metric tons of CO₂ per quad of primary energy. Data source: Energy Information Administration, *International Energy Annual*, Table H.1, "Carbon Dioxide Emissions from the Consumption and Flaring of Fossil Fuels, 1980-2004," July 2006, <http://www.eia.doe.gov/pub/international/iealf/tableh1CO2.xls> and Energy Information Administration, *International Energy Annual*, Table E.1, "World Primary Energy Consumption (Quadrillion Btu), 1980-2004," July 2006, <http://www.eia.doe.gov/pub/international/iealf/tablee1.xls>.

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- ⁴ U.S. Department of Energy, Energy Information Administration, “Chapter 3; World Oil Markets” in *International Energy Outlook 2006*, Report #:DOE/EIA-0484(2006), June 2006.
- ⁵ Data Source: Energy Information Administration, *Monthly Energy Review (MER)*, available online at: <http://www.eia.doe.gov/emeu/mer/contents.html> and Energy Information Administration, *Environment*, November 2006, available online at: <http://www.eia.doe.gov/environment.html> Calculations by authors.
- ⁶ Data source: Energy Information Administration, *Monthly Energy Review (MER)*, Available online at: <http://www.eia.doe.gov/emeu/mer/contents.html>. Calculations by authors.
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